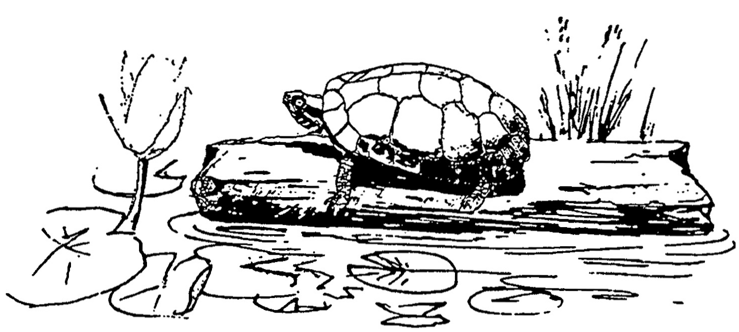
Water Quality Study
of Chenoweth Run



Kentucky Natural Resources and Environmental Protection Cabinet
Department for Environmental Protection
Division of Water
June 1996

WATER QUALITY STUDY OF CHENOWETH RUN

Kentucky Department for Environmental Protection
Division of Water
KPDES Branch

June 1996

This report has been approved for release:

Jack A. Wilson

Jack A. Wilson, Director
Division of Water

June 28, 1996

Date

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ACKNOWLEDGMENTS

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INTRODUCTION

Chenoweth Run, a tributary of Floyds Fork, lies entirely within Jefferson County, Kentucky. The headwater is just north of Interstate 64, and the stream flows nine miles to its confluence at mile 24.2 of Floyds Fork. Chenoweth Run flows through a densely developed area in the Bluegrass Industrial Park, past the city of Jeffersontown, then through a lower-density urban area, and the last three miles through a mostly rural area. Additional development is occurring throughout the entire watershed. The Jeffersontown Wastewater Treatment Plant (J-town WWTP), with a design flow of 4 million ga11ons per day (mgd), is located on Chenoweth Run at mile 5.2. Two other relatively sma11 treatment plants serve individual developments and are located on tributaries (Figure 1, Table 1.).

In late 1992, the Kentucky Division of Water (KDOW) became increasingly concerned about water quality conditions in Chenoweth Run and its impacts on Floyds Fork. A proposed new wastewater treatment plant at mile 1.8 to serve a planned development, plus the concern of two local environmental groups, prompted the KDOW to further investigate water quality conditions. County government also became increasingly concerned about these conditions and formed a task force of local officials and citizens to delineate ideas and suggestion for improvement. A report that covers guidelines for new development in the basin is currently being drafted by a consulting firm for Jefferson County.

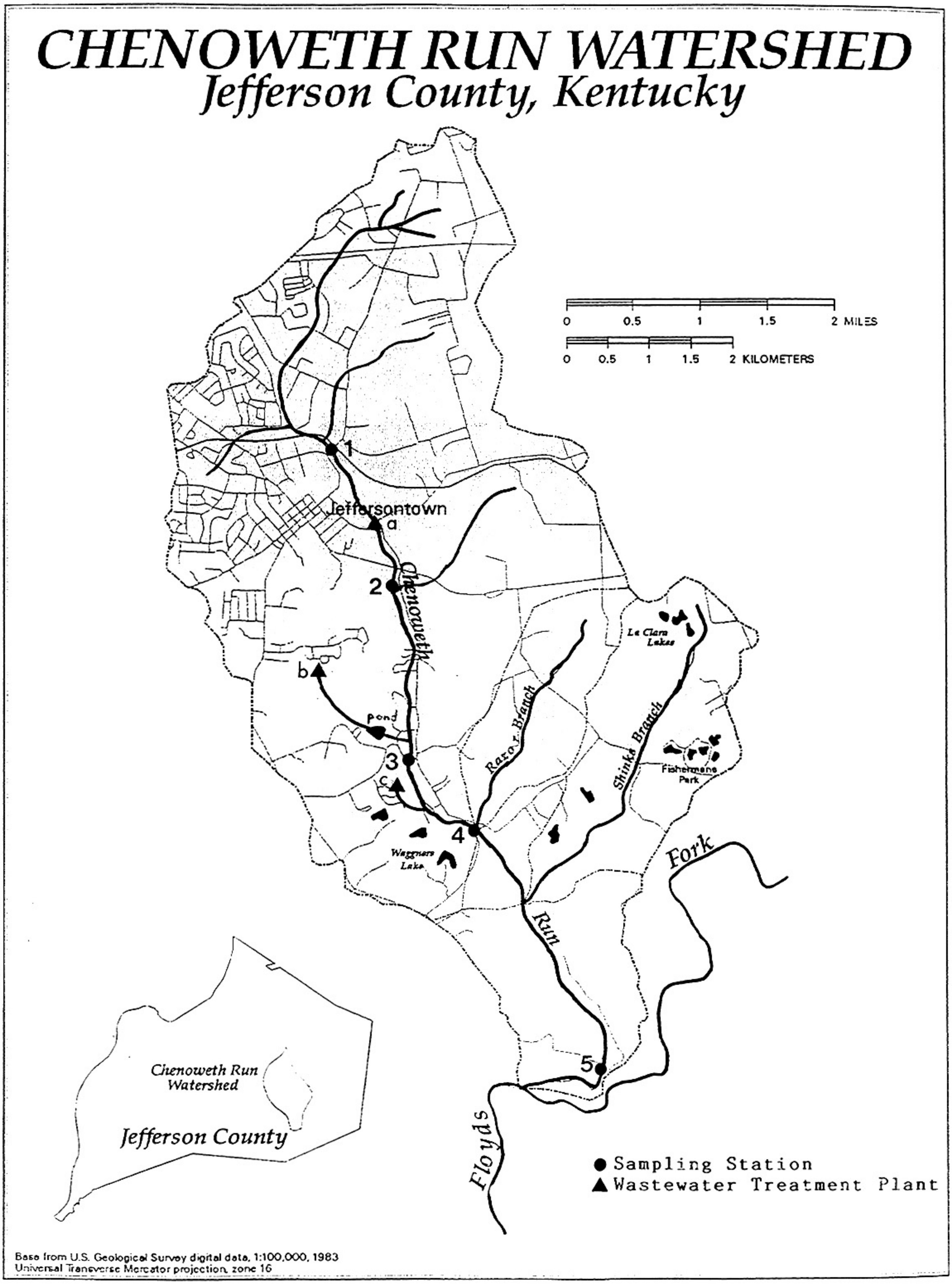

CHENOWETH RUN WATERSHED
Jefferson County, Kentucky
0 0.5 1 1.5 2 MILES
0 0.5 1 1.5 2 KILOMETERS
1
Jeffersontown
a
2
Chenoweth
b
pond
3
c
4
Waggners Lake
Razor Branch
Le Clare Lakes
Shinks Branch
Fishermens Park
Run
Fork
5
Floyds
Chenoweth Run Watershed
Jefferson County
Sampling Station
Wastewater Treatment Plant
Base from U.S. Geological Survey digital data, 1:100,000, 1983
Universal Transverse Mercator projection, zone 16

TABLE 1. WASTEWATER TREATMENT PLANTS IN CHENOWETH RUN	
Map	Design Flow (mgd)*
a) Jeffersontown	4.0
b) Chenoweth Hills	0.20
c) Lake of the Woods	0.04
* Million gallons per day	

TABLE 2. SAMPLING STATIONS IN CHENOWETH RUN	
Map	
1.	Chenoweth Run at Watterson Trail, above the J-town WWTP
2.	Chenoweth Run at Taylorsville Road
3.	Chenoweth Run at Easum Road
4.	Chenoweth Run at Gelhaus Lane
5.	Chenoweth Run at Seatonville Road

Various data have been collected previously in Chenoweth Run and streams throughout Jefferson County. In 1986, the KDOW published a report on conditions in the Floyds Fork basin. This report included information from a sampling station on Chenoweth Run. In 1988, the Metropolitan Sewer District (MSD), in cooperation with the U.S. Geological Survey (USGS), began collecting water quality data throughout the county. Both agencies have published a series of reports describing water quality conditions. Water quality problems were found in every stream in the county, including Chenoweth Run. The most significant problems in Chenoweth Run and Floyds Fork downstream of Chenoweth Run were with dense nuisance growths of algae, causing both aesthetic problems and water quality criteria violations of dissolved oxygen, pH, and ammonia toxicity. Fueling this algal growth was an excess of nutrients, with phosphorus considered the nutrient of most concern. In 1989, Chenoweth Run had the highest average total phosphorus concentration collected from 26 sites in Jefferson County, with a value of 1.58 mg/L (MSD, 1990).

As a result of this existing information, the KDOW placed a phosphorus removal requirement for a proposed facility, began requiring phosphorus monitoring at the J-town WWTP, and applied for a U.S. Environmental Protection Agency (EPA) grant to further determine the sources and extent of the problems in Chenoweth Run. (The plans for the proposed facility have since been canceled. The development, if built, will connect to an existing MSD facility on

Cedar Creek, outside of the Chenoweth Run watershed). The EPA awarded the grant in 1994, and a meeting was held with local government and concerned citizens to refine the study plan. Sampling began in January 1995.

DESCRIPTION OF STUDY AREA

Chenoweth Run drains about 17 square miles of Jefferson County and flows about 9 miles to its confluence with Floyds Fork. The location of the J-town WWTP represents a dividing point in land use. The drainage area above the facility, about 7 square miles, is intensely developed by both residential areas and the Bluegrass Industrial Park. Much of the downtown area of Jeffersontown is within this drainage area. The industrial park consists primarily of light industry, office, and warehouse areas. A new church complex, including a 50-acre parking lot and associated buildings, is currently under construction at the very headwaters. The stream channel through much of the area above the J-town WWTP lies within very steep, tree-lined banks. Large drain pipes carry storm runoff from parking lots, rooftops, and other areas directly to the creek. Buffer zones, or areas of vegetation beyond the stream banks are sparse. Stream slope is moderate and averages about IS feet per mile. The area downstream of the J-town WWTP is much less developed, with some areas of rural and agricultural use. Subdivision development has occurred in this area, and more is either planned or under construction. Stream banks are much less steep, and buffer zones still remain in much of the area. A significant tree canopy, however, does not exist in much of this length, and the stream is exposed to direct sunlight in many places. Stream slopes are again moderate, averaging about 13 feet per mile.

Fish are observed throughout the basin. Pools exist at several locations below the J-town WWTP, and larger sport fish can be seen in these pools, including bass and bluegill. Similar fish observations were also noted in the 1986 KDOW report. Ducks are routinely present in Chenoweth Run and during winter months are seen at the J-town WWTP outfall. Presumably the ducks favor the warmer effluent waters.

DATA COLLECTION

Five sampling stations were used for this study (Figure I and Table 2). Samples were collected monthly from January 1995 to January 1996, with additional samples collected during both extreme low-flow and high-flow conditions. Samples were also collected from the effluent of the J-town WWTP. The USGS measured streamflow and collected the samples under contract with the KDOW as part of the EPA grant. MSD staff continued to collect their normal samples at the Gelhaus Lane station. Coordination between the USGS and MSD was accomplished, and the samples at Gelhaus Lane and the two Floyds Fork stations in MSD's network were collected on the same days. Data collected by MSD at their stations are undergoing MSD internal review and.are not published in this report. Samples were analyzed by MSD in its laboratory. Staff from KDOW also conducted some additional sampling and algal collection. A separate report is being prepared by the KDOW for the algal analysis.

Water samples were analyzed for BOD, ammonia, dissolved oxygen, temperature, pH, total phosphorus, nitrite plus nitrate nitrogen, suspended solids, and fecal coliform bacteria. An error was discovered with the holding times for the fecal coliform bacteria samples, and the results were found to be invalid and are not reported. Metals data were collected twice for this study, once for low-flow conditions and once after a heavy rainfall event. Samples for metals were analyzed by the Kentucky Division of Environmental Services lab in Frankfort.

Dissolved oxygen, pH, and water temperature were measured every 30 minutes for periods ranging from 22 to 24 hours at three sampling stations during one low-flow period. Hydrolab automatic datasonde units were used. These had been calibrated in the office the day prior to deployment, and instantaneous stream measurements were made when setting and removing the units to ensure data accuracy.

Streamflow conditions were variable for this study, ranging from a low of 0.13 cubic feet per second (cfs) above the J-town WWTP during low flows to 331 cfs at the Seatonville Road station after a heavy storm event. These conditions met the study goal of sampling a variety of hydrologic events.

NUTRIENT PROBLEMS AND CONTROL

Nutrients, primarily phosphorus and nitrogen, stimulate the growth of aquatic plants just as they do for land plants. The chlorophyl-bearing algae and rooted aquatic plants cause the most concern. Algae can proliferate where nutrient concentrations and light intensities are sufficient. The definition of 'sufficient' varies from stream to stream and is the focus of national research by the EPA and others. This algal proliferation can be greatly accelerated in streams and lakes with excess nutrients and sunlight. Algal blooms may occur, creating water quality problems with dissolved oxygen, pH, ammonia toxicity, aesthetics, and taste and odor in the water if used for public consumption. As algae die, decomposition can release foul odors and deplete dissolved oxygen to the point of causing fish kills. As algae respire at night or during extended periods of cloud cover, dissolved oxygen depletion can also become severe. These problems most often occur in lakes, but can also occur in streams. Streams with low slopes and little riparian tree cover have the greatest potential for algal blooms.

Aquatic plant growth can be inhibited by eliminating one or more of the critical elements. Velz (1970) notes that phosphorus is the most likely nutrient to be controlled. He says, however, that "the critical concentration level of phosphorus to inhibit algal growth remains in question. It has been considered as 0.1 milligrams per liter (mg/L), yet growth in lakes has persisted with no change in the amount of bloom when concentration in the receiving waters was reduced from 0.5 to 0.07 mg/L." He further states, "Nutrient control is highly complex. To some authorities it is conceivable that the uncontrollable sources from the urban, agricultural, and natural environments in general may maintain nutrients above critical levels even though all nutrients were to be removed from wastewater effluents."

Perhaps of equal importance to nutrient reduction is the protection or re-establishment of stream riparian zones. The following is an article from the December 1995 issue of "Water Environment & Technology" magazine.

> Shade Clears Streams
> When watersheds are developed and trees are cut down, streams that should be recreational resources often become clogged with thick blankets of algae. Working at the University of Michigan's Stream Research Facility near Pellston, Mich., R. Jan Stevenson, Professor of Biology at the University of Louisville, Kentucky, has found that when a stream loses its shade, the type of algae in the stream changes from species that insect larvae and snails eat to those that have no natural predators. Restoring vegetation and shade in riparian areas reverses this process, allowing edible algae, whose numbers are kept down by snails and insect larvae, to once again dominate, and the streams to once again become community recreational assets.

Because of the complexities of algal blooms, nutrient contribution, and stream dynamics (stream slope, flow, shade, etc.) there is no federal or state standard for phosphorus. The EPA, as well as the states, recognizes the need for nutrient control. As reported in the December 1994 "Inside EPA's Water Policy Report," the EPA is forming a nutrients water quality work group as part of its efforts to develop nutrient criteria. Director Robert Wayland, of EPA's Office of Wetlands, Oceans, and Waterbodies, notes his office will be working on "some badly needed criteria for nutrients in different types of waterbodies, including rivers, streams, lakes, and estuaries." The effort is to try to avoid eutrophication and nutrient enrichment that causes algal blooms. This is reflected in narrative form in KDOW Regulation 5:031, Section 1, which states: "Nutrient Limits. In lakes, surface impoundments and their tributaries, and other surface waters where eutrophication problems may exist, nitrogen, phosphorus, carbon, and contributing trace elements discharges will be limited as appropriate by the cabinet."

Nutrient control is obviously not a problem unique to Chenoweth Run, but has a national focus. Although algal blooms are nothing new, research into controlling the problem is relatively recent. Solutions found from this effort will ultimately address this aspect of stream degradation.

WATER QUALITY IN CHENOWETH RUN IN 1995

The primary focus of data collection in 1995 was on phosphorus concentrations in Chenoweth Run and the source(s) of this phosphorus. Median total phosphorus concentrations in 1995 were found to be 0.04 mg/L above the J-town WWTP, 2.5 mg/L in the plant effluent, 1.4 mg/L a short distance downstream, and concentrations remained elevated throughout Chenoweth Run to its confluence with Floyds Fork (Table 3, Figure 2). The value commonly recommended by the EPA for flowing streams is 0.1 mg/L (EPA, 1986), but as previously discussed, there is no stream standard for phosphorus. A further analysis of these data (Figure 3) shows that the J-town WWTP has the greatest impact on phosphorus concentrations in Chenoweth Run during low to normal streamflow. During high streamflow events, the plant has little impact on concentrations in the stream. During storms, the nonpoint source contribution is much more significant, and concentrations are essentially the same (about 0.3 mg/L) above the plant as below. The most likely source during storm runoff is from fertilizers used on lawns, both for homes and in the industrial park. Most of the industries have well-maintained "lawns" around buildings and parking lots. During normal summertime conditions when algal blooms are prevalent, the primary source of the phosphorus is the J-town WWTP.

Perhaps the most interesting facet of the 1995 study is that the thick algal blooms that have been observed in previous summers

Table 3. Water Quality Data in Chenoweth Run in 1995

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
			Stream Flow (cubic feet per second)					
Above Treatment Plant	16	0.13	0.26	0.81	2.41	15.70	155.87	293.00
Treatment Plant Effluent *	12	3.47	3.48	3.58	3.95	4.81	7.53	7.55
At Taylorsville Road	15	4.02	4.16	5.05	10.20	29.60	140.26	211.00
At Easum Road	15	3.58	4.22	6.11	11.10	40.90	171.60	252.00
At Seatonville Road	15	1.81	2.58	5.65	14.90	53.70	217.60	331.00
			Dissolved Oxygen (mg/L)					
Above Treatment Plant	19	6.0	7.2	7.7	9.1	12.3	13.8	14.2
Treatment Plant Effluent	15	4.0	5.0	7.1	8.0	8.5	9.6	9.9
At Taylorsville Road	18	7.4	7.8	8.4	10.4	12.4	14.1	14.2
At Easum Road	14	7.7	7.8	9.6	12.5	14.5	18.5	20.0
At Seatonville Road	16	8.2	8.6	10.0	12.4	15.3	18.9	23.9
			pH (standard units)					
Above Treatment Plant	19	6.2	6.3	6.6	7.6	7.9	8.1	8.2
Treatment Plant Effluent	16	6.5	6.6	6.8	7.4	7.7	8.7	8.8
At Taylorsville Road	19	6.6	6.8	7.0	7.4	7.8	8.2	9.2
At Easum Road	15	6.5	6.9	7.4	7.9	8.6	8.8	8.8
At Seatonville Road	19	6.6	7.1	7.4	8.2	8.7	9.1	10.6
			BOD (mg/L)					
Above Treatment Plant	17	1.	1.	1.	2.	4.	4.	5.
Treatment Plant Effluent	16	1.	2.	2.	3.	8.	10.	10.
At Taylorsville Road	17	1.	1.	2.	2.	5.	5.	5.
At Easum Road	15	1.	1.	1.	2.	4.	5.	6.
At Seatonville Road	17	1.	1.	1.	2.	4.	6.	8.
			Total Phosphorus (mg/L)					
Above Treatment Plant	15	0.01	0.02	0.02	0.04	0.12	0.35	0.36
Treatment Plant Effluent	12	0.86	0.99	1.50	2.50	3.33	3.97	4.00
At Taylorsville Road	15	0.34	0.35	0.68	1.40	2.90	3.27	3.53
At Easum Road	12	0.31	0.32	0.43	0.63	2.15	2.61	2.70
At Seatonville Road	17	0.14	0.24	0.32	0.75	1.55	2.34	2.92

* During high streamflow events, plant flow was not measured.

Table 3. Water Quality Data in Chenoweth Run in 1995 (cont.)

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
			Water Temperature (degrees C)					
Above Treatment Plant	19	1.0	3.5	5.0	14.6	21.0	21.5	22.0
Treatment Plant Effluent	15	5.0	7.1	11.5	17.2	22.5	24.9	25.5
At Taylorsville Road	18	5.0	5.9	8.0	16.8	23.4	25.4	25.5
At Easum Road	15	3.0	3.0	4.0	16.0	23.0	24.9	25.5
At Seatonville Road	19	0.5	2.5	5.0	19.0	23.7	25.5	26.0
			Total Suspended Solids (mg/L)					
Above Treatment Plant	19	1.	2.	5.	9.	36.	146.	440.
Treatment Plant Effluent	16	1.	1.	3.	7.	9.	14.	18.
At Taylorsville Road	19	1.	2.	5.	6.	18.	196.	234.
At Easum Road	15	1.	2.	4.	6.	53.	153.	230.
At Seatonville Road	19	1.	2.	3.	6.	26.	118.	124.
			Ammonia nitrogen (mg/L as N)					
Above Treatment Plant	19	0.02	0.02	0.04	0.05	0.07	0.20	0.24
Treatment Plant Effluent	16	0.03	0.03	0.06	0.19	0.84	1.49	1.70
At Taylorsville Road	19	0.02	0.02	0.05	0.11	0.39	0.80	0.82
At Easum Road	15	0.01	0.02	0.04	0.10	0.26	0.57	0.60
At Seatonville Road	19	0.01	0.03	0.05	0.08	0.12	0.64	0.69
			Nitrite plus Nitrate Nitrogen (mg/L as N)					
Above Treatment Plant	18	0.26	0.44	0.65	1.13	1.32	1.70	1.70
Treatment Plant Effluent	15	0.88	1.19	4.60	9.60	13.00	18.94	19.00
At Taylorsville Road	18	1.20	1.74	3.70	5.60	11.05	12.30	15.00
At Easum Road	15	1.10	1.40	2.80	3.50	6.70	11.60	14.00
At Seatonville Road	18	0.94	1.35	2.17	4.00	7.63	10.16	13.00

Figure 2. Total Phosphorus in Chenoweth Run in 1995

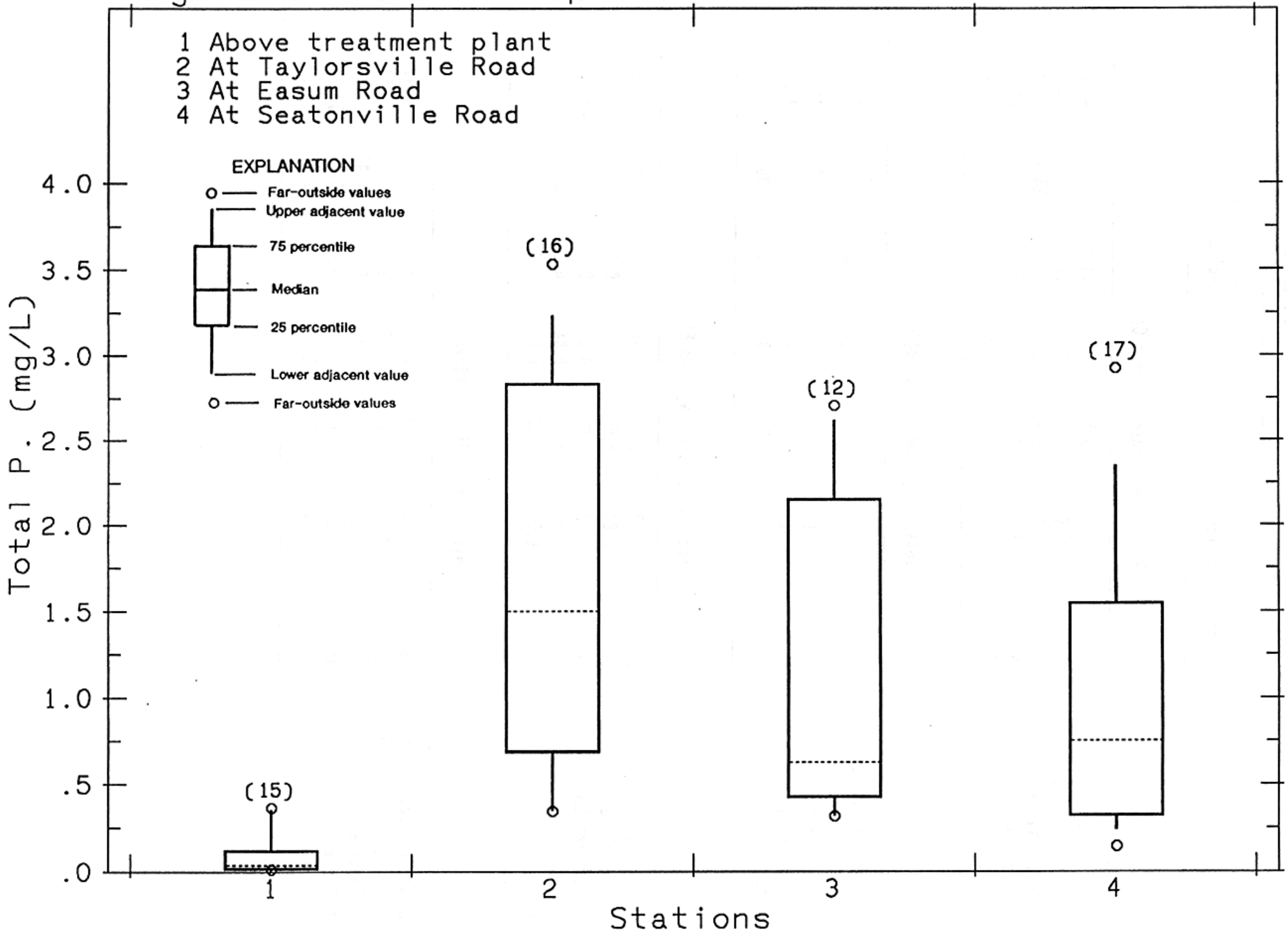
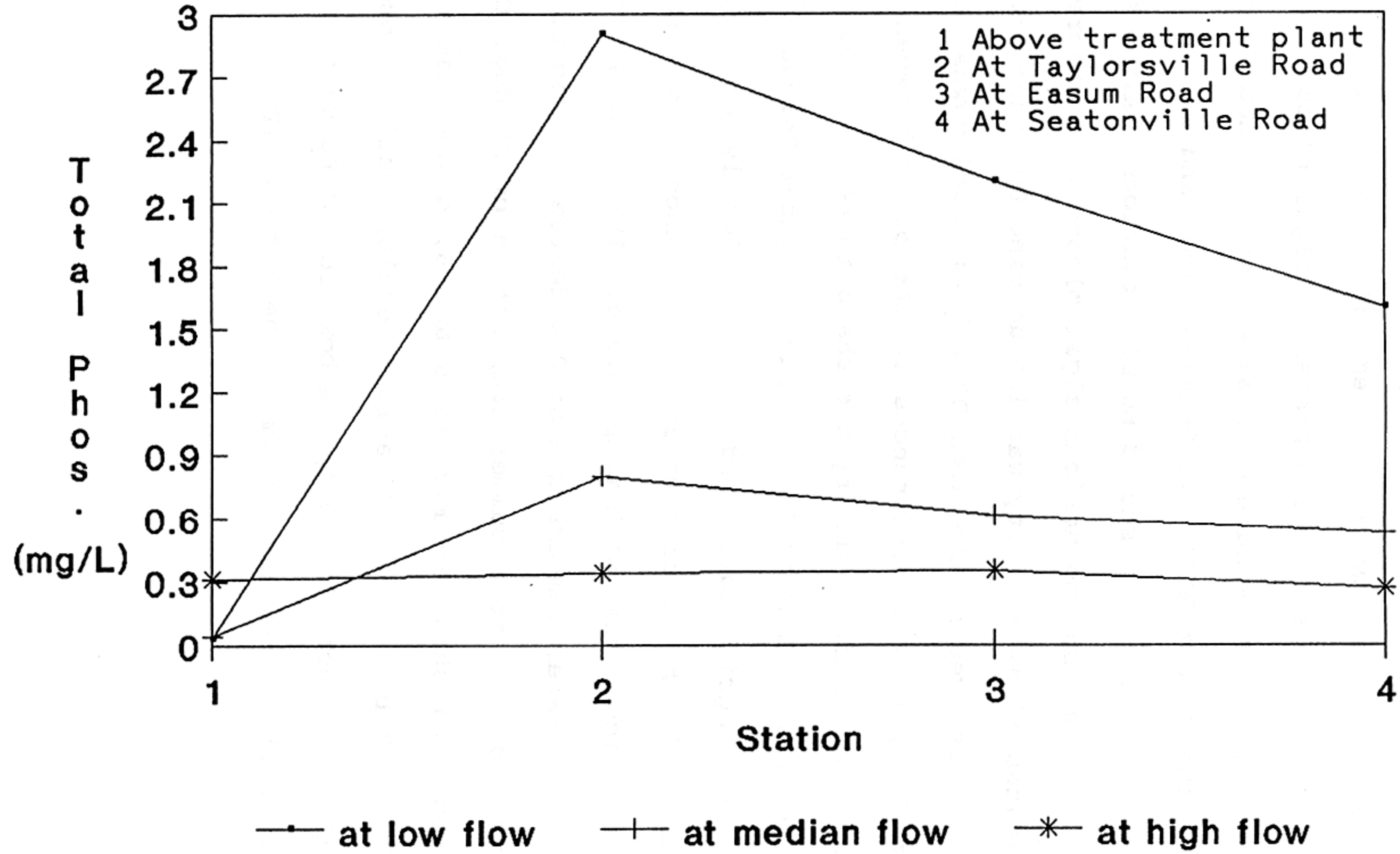


Figure 3. Total Phosphorus in Chenoweth Run During Different Streamflow Conditions



did not occur, and there were no dissolved oxygen (DO) violations measured in Chenoweth Run. Intense storms, especially in May, and the high streamflows associated with these storms, scoured the algae out of the stream and prevented algal blooms from occurring. Dissolved oxygen measurements made over a 24-hour period at sites above the J-town WWTP, at Gelhaus Lane, and at Seatonville Road (Figures 4, 5, and 6) showed no DO violations. Although there were no violations and no noxious algal blooms were observed, the data indicates algal activity was influencing DO concentrations. This can be observed by the high DO values found downstream of the J-town WWTP, by the differences in the plots between upstream and downstream stations, and by the sharp increase in Do after sunrise at the Gelhaus Lane station. (The area near Gelhaus Lane has been used f or agriculture, and there is hardly any remaining tree cover.) "High" DO concentrations are those above the saturation point, which varies with temperature. This ranges from about 14.6 mg/L at a water temperature of 0.0 degrees centigrade (deg. C) to about 8.0 mg/L at a summer temperature of 25 deg. C. Dissolved oxygen data shown in Figures 5 and 6, downstream of the J-town WWTP, exhibit supersaturation levels, while those above the facility did not (Figure 4). A box plot of DO data (Figure 7) also shows high levels downstream of the J-town WWTP.